PAWR Project Office

March 1, 2019

Ira Keltz, Chief
Electromagnetic Compatibility Division
Office of Engineering and Technology
Federal Communications Commission
445 12th Street SW
Washington, DC 20554

Dear Mr. Keltz:

As we have previously discussed, I am writing to you in my role as the Principal Investigator and Project Director for the Platforms for Advanced Wireless Research Project Office. As a part of this project, we are requesting that the FCC establish two Innovation Zones, one in New York City, and the other in Salt Lake City, per 47 CFR 5.313 and the Public Notice published on April 14, 2017. Further details about the project and this request are below.

Innovations in wireless communication networks and applications relying on them have now become vital components driving the nation's economic growth and productivity. Sustaining the rapid growth in these technologies is essential to maintaining the nation's leadership and economic competitiveness. In July 2016, the National Science Foundation announced a multi-year effort, called Platforms for Advanced Wireless Research (PAWR), aimed at creating a set of city-scale testbeds to promote research in advanced wireless communication and networking technologies over the next decade. In this effort, the NSF was joined by a Consortium of 29 technology and telecommunications companies, including all four major US wireless carriers, with commercial interests in the wireless technologies resulting from this investment. PAWR will enable experimental exploration of robust new wireless devices, communication techniques, networks, systems, and services that will revolutionize the nation's wireless ecosystem, thereby enhancing broadband connectivity, leveraging the emerging Internet of Things (IoT), and sustaining US leadership and economic competitiveness for decades to come. PAWR will also enable rapid commercialization of promising technologies, bringing jobs and economic vitality. Researchers will have access to realistic, city-scale testbeds for testing new wireless theories and concepts, while a whole new generation of participating graduate students will emerge with hands-on practical training.

In order to support the design, development, deployment, and operations of the advanced wireless research platforms, the National Science Foundation's (NSF) Directorate for Computer and Information Science and Engineering (CISE) selected US Ignite and Northeastern University to form the PAWR Project Office (PPO). Working closely with the wireless research community, the PPO has responsibility for design, development, and deployment of a set of advanced wireless research platforms. Upon successful completion of the design of advanced wireless research platforms, the PPO will proceed to the development and deployment phases with funding provided by NSF as well as the 29-company Industry Consortium. The PPO will professionally establish and manage the advanced Research Platforms needed to unleash American innovation, drive economic development, and help extend US global leadership in

the wireless industry. The PPO works closely with the wireless research community in all aspects of the design, development, deployment, and operations of PAWR. A PAWR Steering Council (PSC), comprising research leaders in wireless networking technologies and a subset of the Industry Consortium, represents the community's research interests in PAWR. The PSC is chartered and supported by the PPO, with the goal of obtaining advice on all aspects of the deployment and operations of the advanced wireless research platforms.

The PPO is the main point of consolidation and oversight for all funds and resources contributed by the Industry Consortium and NSF to construct and operate the platforms. Upon selection and approval of a platform location and operator, the PPO will subaward a total of $50 million in funds to the selected project and, at the same time, issues up to an additional $50 million in equipment, funds, and other resources promised by Industry Consortium partners necessary for the deployment of this platform. The PPO then governs the release of these funds and resources to the platform via suitable funding vehicles (e.g., subawards, contracts, gifts), subject to the platform's adherence to the project plan and reporting and compliance milestones.

In March 2018, the PPO concluded its first-round selection of two platforms:

- **COSMOS**, run jointly by Rutgers University, Columbia University, and New York University in partnership with the city of New York and located in west Harlem; and
- **POWDER**, run jointly by the University of Utah and Rice University in partnership with and located in Salt Lake City.

In order to operate these wireless research platforms most effectively, the PPO is requesting FCC designation of 2 Innovation Zones – on each in New York City and Salt Lake City. The research platforms are described in further depth below. The geographic boundaries and frequencies of operation of each requested Innovation Zone are detailed in **Exhibit 1 and 2** respectively. Per our discussions, the PPO, represented by PAWR, LLC (FRN: **0027193036**) proposes that it be the designated entity responsible for these Innovation Zones.

Below, please find a brief description of the COSMOS and POWDER platforms.

COSMOS: Cloud Enhanced Open Software Defined Mobile Wireless Testbed for City-Scale Deployment

This project creates a city-scale platform for advanced wireless research that will be deployed over the period 2018 - 2023 in New York City, NY. This Cloud Enhanced Open Software Defined Mobile Wireless Testbed for City-Scale Deployment (COSMOS) supports at-scale experimentation of novel advanced wireless broadband and communication technologies in the sub-6 GHz bands and in the millimeter wave frequency bands in a densely populated, urban setting. The project features interactions with regional networks and smart community initiatives including municipalities, non-profits, and various tech communities with interest in contributing to and/or using the testbed for application development. The ability to use this platform by early adopter companies/startups, global telecom industry and application developers to evaluate technologies in their pre-commercial phase will have a significant positive impact on the speed of innovation in the data networking and application domains. This effort will also benefit educators and students at all levels of study in communications-related disciplines.

Radio nodes in COSMOS provide a mix of fully programmable software defined radios (SDRs) for flexible wireless experimentation as well as commercial hardware capable of supporting networking and applications research with currently available end-user devices. COSMOS is built in a bottom-up manner with commodity components and customized open-source hardware and software modules. The developed wireless platforms cover the full range of spectrum including the sub 6 GHz bands used for today's services as well as emerging 28 GHz and 60 GHz millimeter-wave (mmWave) bands. SDRs utilize a new design that achieves an order-of-magnitude performance headroom over current technology, achieving real-time processing of wide bandwidths (~500 MHz) via novel acceleration techniques. The COSMOS platform incorporates fast programmable core network technology to keep pace with significant increases in wireless link bandwidth and to effectively integrate emerging radio access networks with edge cloud computing. The design includes novel 100 Gbps+ fiber, free space optical, and microwave backhaul technologies interconnected with a software-defined network (SDN) switching fabric for minimum latency and flexibility in setting up experimental network topologies. Sub-microsecond optical switching technology offers the option of passive Wavelength-Division Multiplexing (WDM) switch fabrics and radio over fiber interfaces for the purpose of achieving ultra-low latency connections to edge computing services, which will be built in as an integral part of the system. Together, this will enable comprehensive end-to-end experimentation across diverse applications and users with tools for scientific workflow management, collaboration, and artifact sharing, all with a goal towards promoting rigorous standards for reproducibility in this field.

POWDER-RENEW: A Platform for Open Wireless Data-driven Experimental Research with Massive MIMO Capabilities

This project creates a city-scale platform for advanced wireless research that will be deployed over the period 2018 - 2023 in Salt Lake City, Utah. This Platform for Open Wireless Data-driven Experimental Research (POWDER) supports at-scale experimentation of novel advanced wireless broadband and communication technologies in the sub-6 GHz band. The project features interactions with regional networks encompassing initiatives on public transportation, broadband delivery, education and health service delivery as well as advancement of science, technology and research by creating an ecosystem of a hundred small companies in allied technical domains. The ability to use this platform by early adopter companies/startups and application developers to evaluate technologies in their pre-commercial phase will have a significant positive impact on the speed of innovation in the data networking and application domains. This effort will also benefit educators and students at all levels of study in communications-related disciplines.

A key feature of the platform is the partnership with the Reconfigurable Eco-system for Next-generation End-to-end Wireless (RENEW) project at Rice University to develop a highly programmable and flexible massive multi-input multi-output (MIMO) platform that is an essential feature of both 5G and beyond-5G wireless networks. The platform will feature (i) heterogeneous systems composed of programmable base stations, mobile devices and static sensors; (ii) state of the art massive MIMO base-stations; (iii) ability to conduct research over a diverse spectrum range (from 50 MHz to 3.8 GHz), and (iv) a large-scale software defined wireless networking testbed integrated with an existing NSF-funded cloud testbed, thereby enabling end-to-end experimentation. Another unique aspect of the platform is support for wireless mobility-based studies, provided by using couriers with predictable movement patterns (e.g., buses), less predictable but bounded mobility (e.g., maintenance vehicles), and controllable couriers (e.g., on-site volunteers). Each of these deployed units will consist of "base" functionality that includes user-programmable software defined radios, "bring your own device" (BYOD) experiments, and will be

connected via a sophisticated platform control framework. Existing fiber links will connect the wireless base stations to about half a dozen edge compute platforms. This will enable complex device provisioning and a set of tools for scientific workflow management, collaboration, and artifact sharing, with a goal towards promoting rigorous standards for reproducibility in this field.

We understand that there may be further details required by the FCC in consideration of this request. Please do not hesitate to contact us with additional questions or requirements

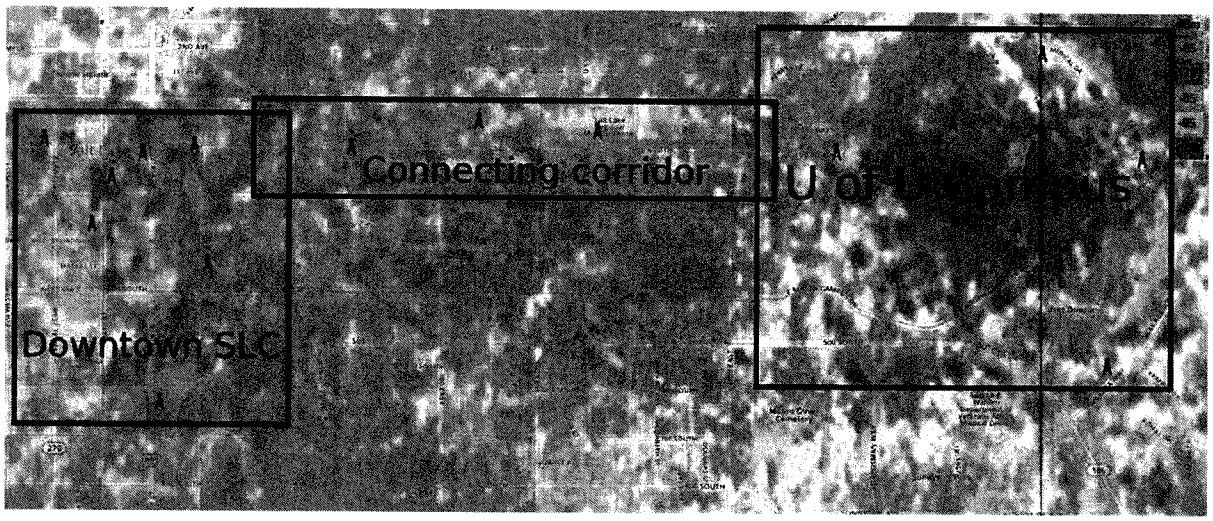
Sincerely,

Joseph Kochan
Project Director

EXHIBIT 1

POWDER

POWDER Locations



Locations 01-07: University of Utah Campus

Coordinates: 40.772 N, 111.835 W (Hospital)

Coordinates: 40.760 N, 111.843 W (Behavioural)

Coordinates: 40.762 N, 111.835 W (Honors)

Coordinates: 40.765 N, 111.828 W (Shoreline Ridge)

Coordinates: 40.768 N, 111.841 W (UStar)

Coordinates: 40.767 N, 111.847 W (Geology)

Coordinates: 40.759 N, 111.829 W (Dentistry)

Locations 08-10: Connecting Corridor

Coordinates: 40.767 N, 111.862 W (SL Regional)

Coordinates: 40.765 N, 111.868 W (Bryant)

Coordinates: 40.767 N, 111.876 W (Ambassador)

Locations 11-17: Downtown

Coordinates: 40.760 N, 111.885 W (SLC Engineering)

Coordinates: 40.766 N, 111.885 W (Tower 102)

Coordinates: 40.767 N, 111.888 W (Orpheum)

Coordinates: 40.767 N, 111.891 W (270 S Main)

Coordinates: 40.762 N, 111.891 W (Walker)

Coordinates: 40.768 N, 111.895 W (Salt Palace East)

Coordinates: 40.755 N, 111.887 W (645 State)

TABLE for POWDER Frequency of Operation

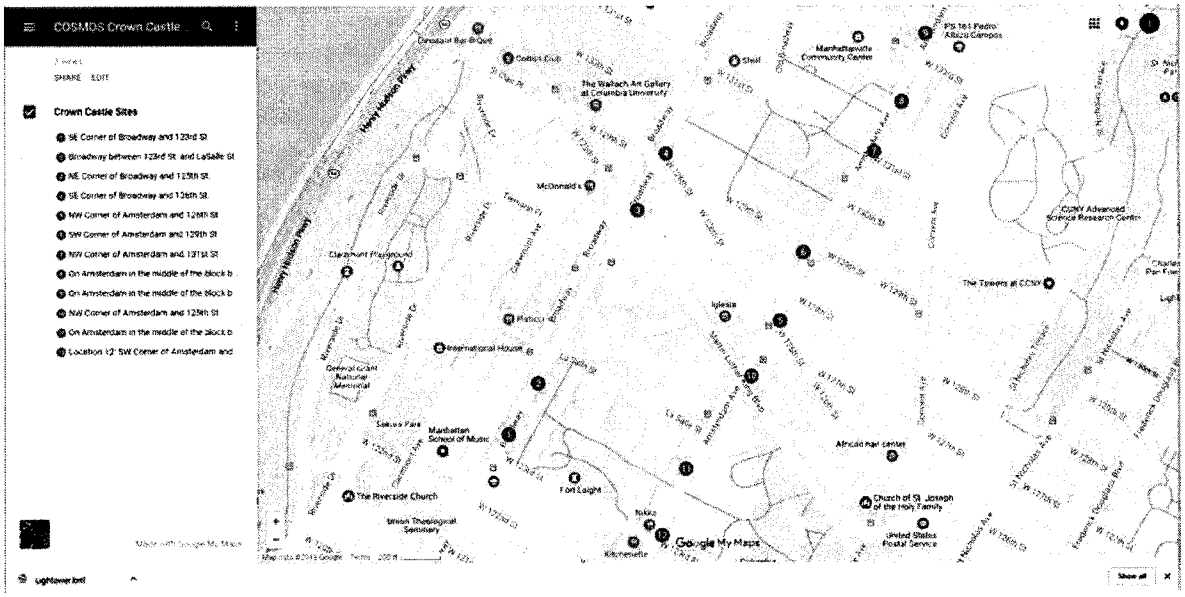
Spectrum Band	Center Freq	Tx Power (dBm)	Technology Enabled	Site location (If Known)	Geographic Region	Fixed or Mobile Transmitter	Radius of Operation	Incumbent Licensee (If Known)
698-763 MHz		+20		Loc01-17	Salt Lake City, UT	Both	1500 m	
914.87-915.13 MHz	915 MHz	+20		Loc01-17	Salt Lake City, UT	Both	1500 m	ISM, Radiolocation
1710-1780 MHz		+20	LTE, 5G		Salt Lake City, UT	Mobile	1500 m	Multiple AWS
2110-2180 MHz		+20	LTE, 5G	Loc01-17	Salt Lake City, UT	Fixed	1500 m	Multiple AWS
2390-2483.5 MHz	2450 MHz	+20	WiFi	Loc01-17	Salt Lake City, UT	Both	1500 m	ISM, Amateur, Radiolocation
3300 Mhz-3600 MHz		+20	AWS, CBRS	Loc01-17	Salt Lake City, UT	Both	1500 m	US Navy, Amateur, Aeronautical
5650-5925 MHz		+20	DSRC		Salt Lake City, UT	Mobile	100 m	

EXHIBIT 2

COSMOS

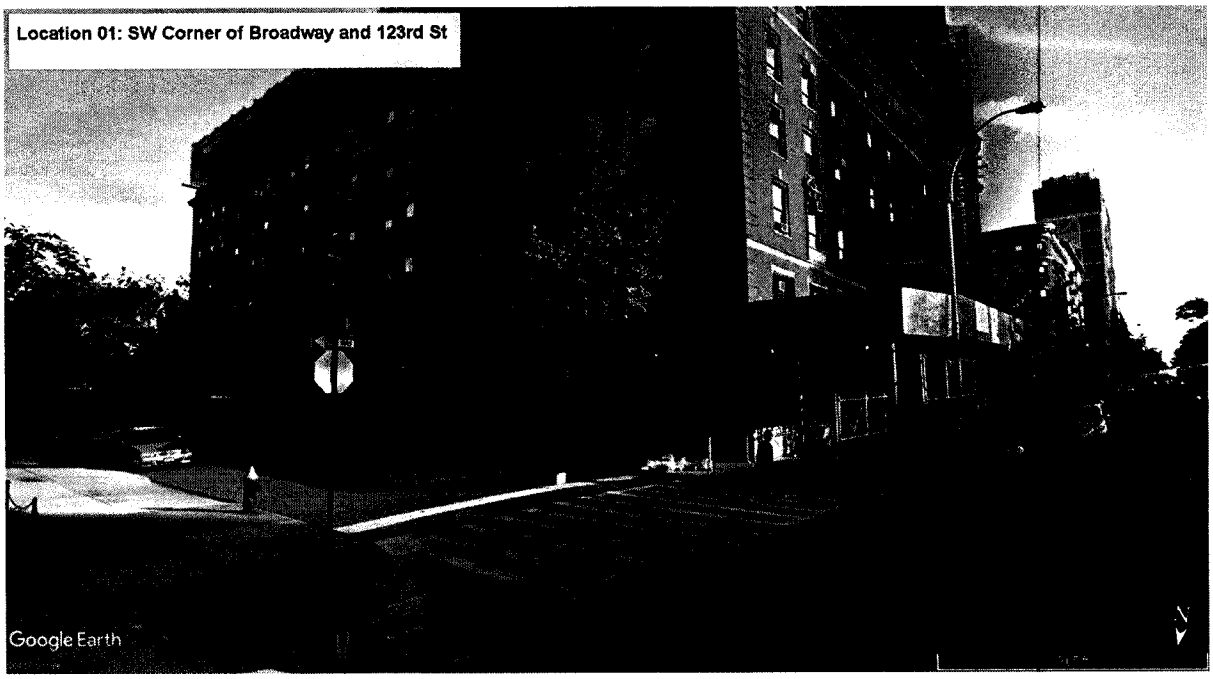
COSMOS Street-level Locations

Map: https://www.google.com/maps/d/u/0/viewer?mid=1oMt1r9M0GESMutBbb4BclLKh_rN55GBg



Location 01: SW Corner of Broadway and 123rd St

Coordinates: 40°48'45.52"N, 73°57'37.19"W



Map:

https://www.google.com/maps/@40.8124188,-73.9605523,3a,75y,155.77h,75.4t/data=!3m6!1e1!3m4!1sbHjKHsbdlVm8xRoxhUOYHA!2e0!7i13312!8i6656

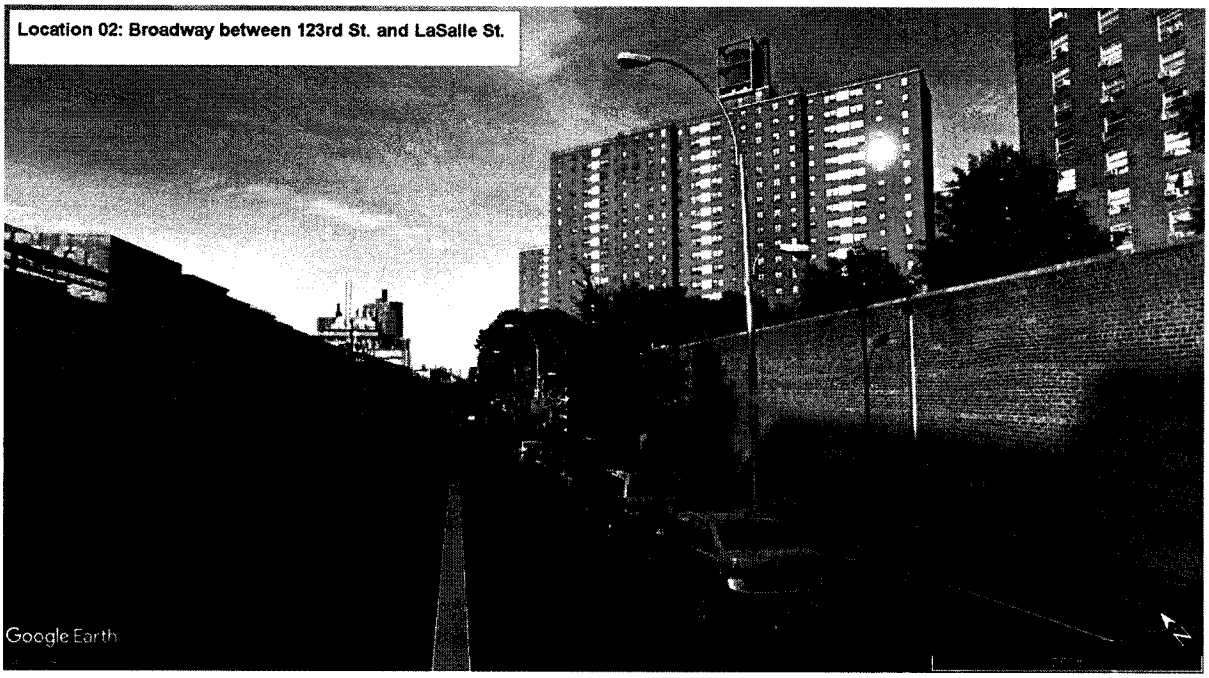
Notes:

Location 02: Broadway between 123rd St. and LaSalle St.

Coordinates: 40°48'47.93"N, 73°57'35.33"W

Map:

https://www.google.com/maps/@40.8133027,-73.9601846,3a,75y,269.87h,83.09t/data=!3m6!1e1!3m4!1sljqo-_G8Qt-qho_3JYABWg!2e0!7i13312!8i6656



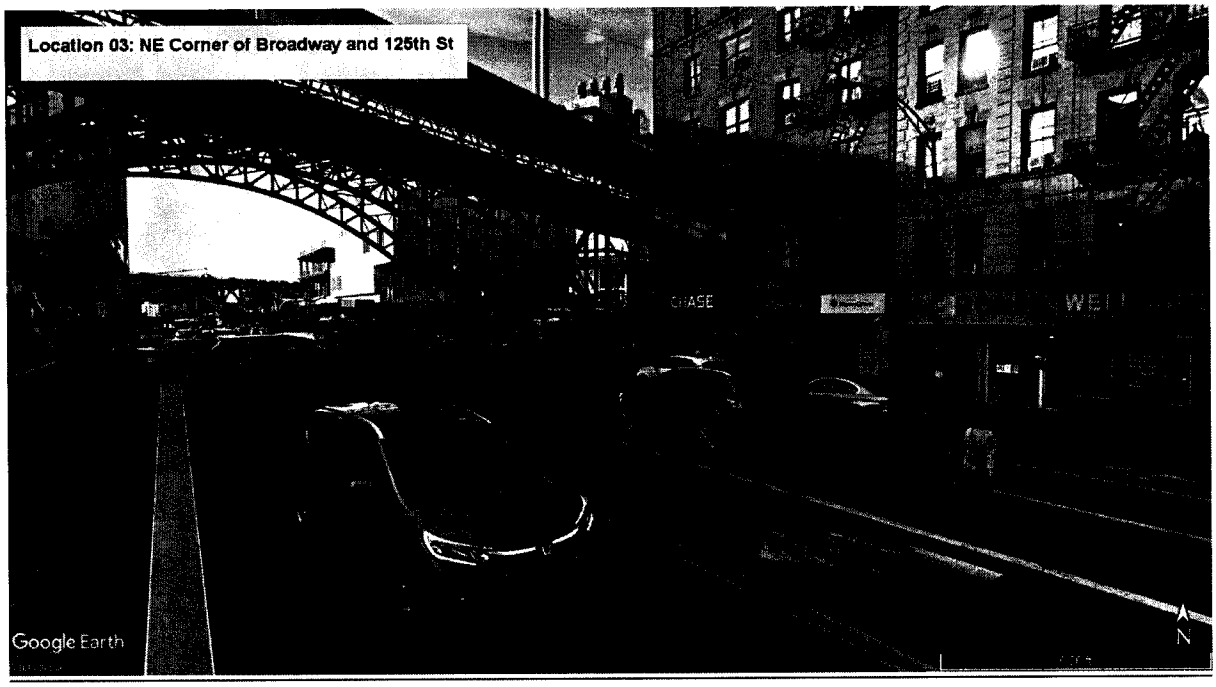
Notes:

Location 03: NE Corner of Broadway and 125th St.

Coordinates: 40°48'56.21"N, 73°57'29.08"W

Map:

https://www.google.com/maps/@40.8154276,-73.958121,3a,75y,44.86h,86.54t/data=!3m6!1e1!3m4!1sCyYPIUu2q2XJrFB8yt7gIg!2e0!7i13312!8i6656

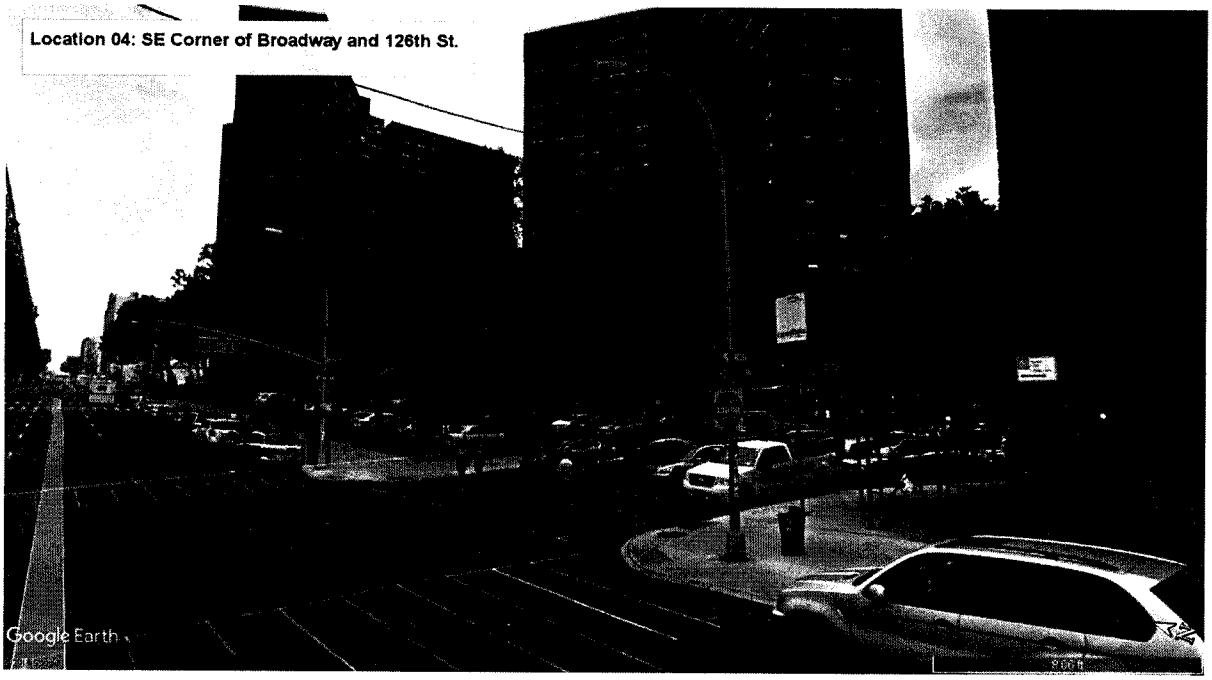


Notes:

Location 04: SE Corner of Broadway and 126th St.

Coordinates: 40°48'58.93"N, 73°57'27.26"W

Map:

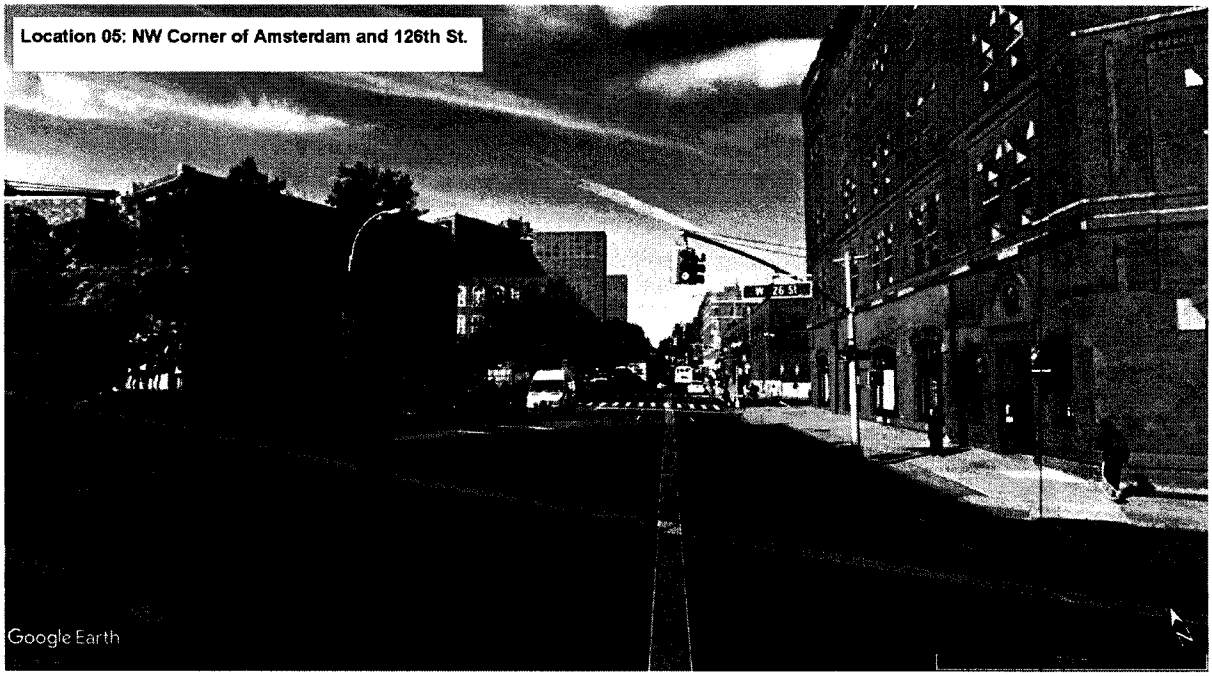


Notes:

Location 05: NW Corner of Amsterdam and 126th St.

Coordinates: 40°48'48.24"N, 73°57'21.95"W

Map:

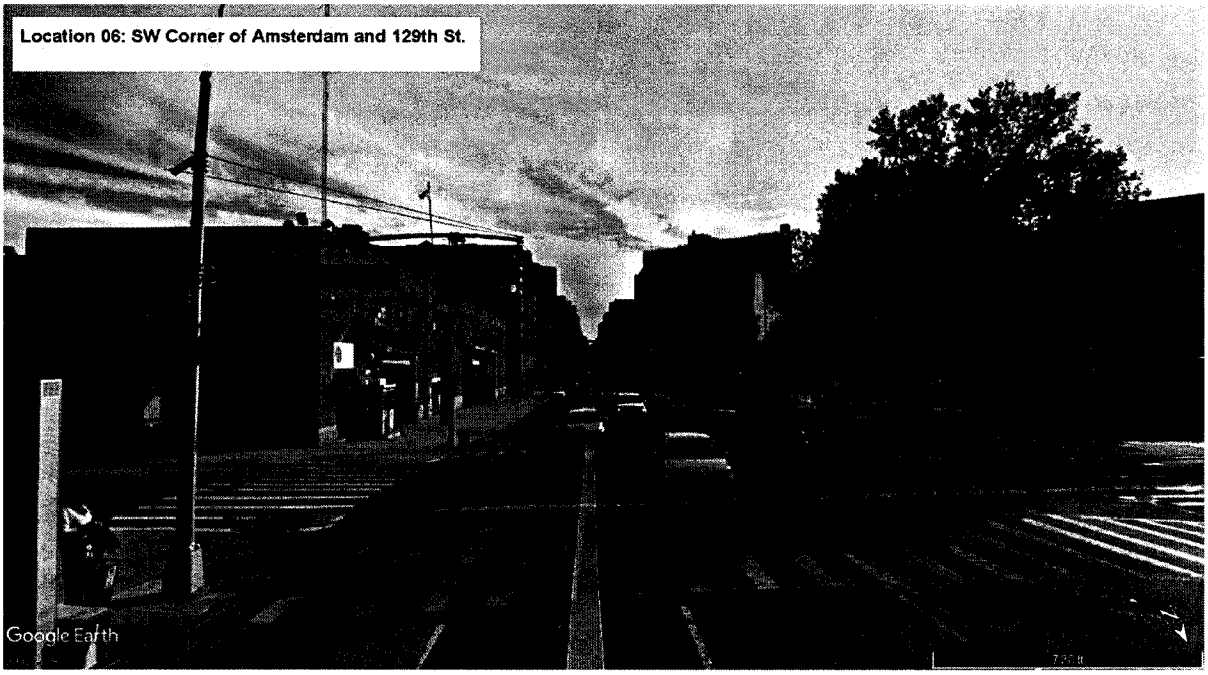


Notes:

Location 06: SW Corner of Amsterdam and 129th St.

Coordinates: 40°48'54.18"N, 73°57'18.67"W

Map:



Notes:

Location 07: NW Corner of Amsterdam and 131st St.

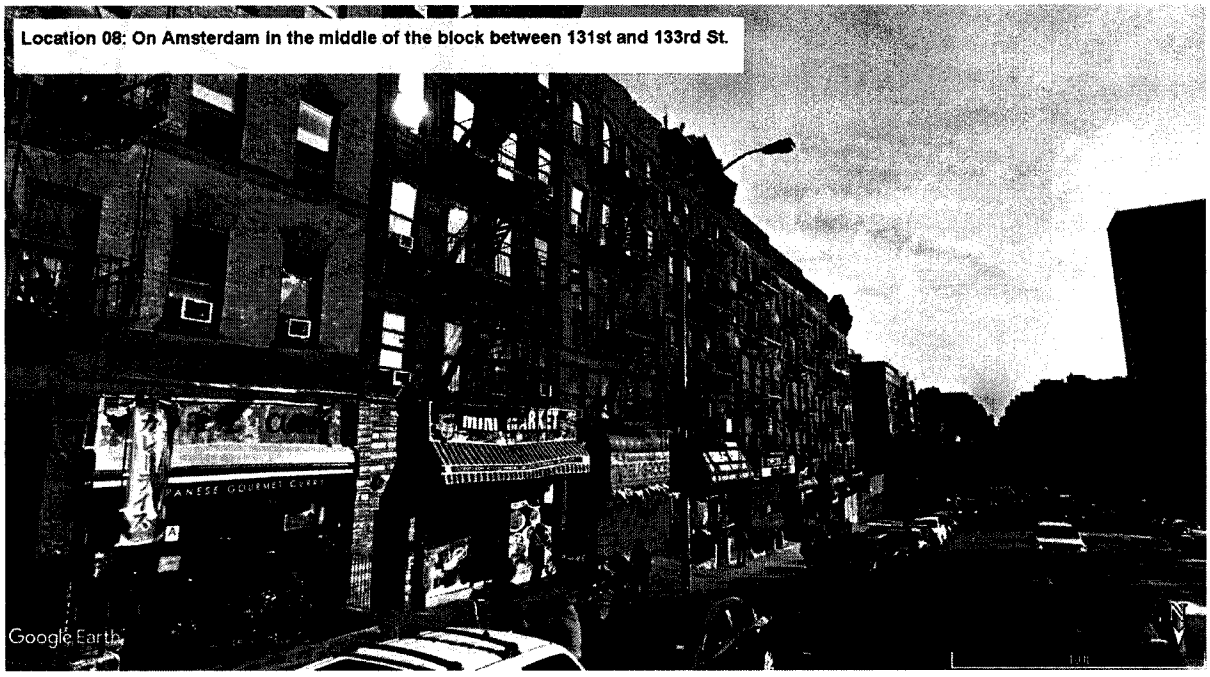
Coordinates: 40°48'59.01"N, 73°57'14.24"W

Map:

Notes:

Location 08: On Amsterdam in the middle of the block between 131st and 133rd St.
Coordinates: 40°49'1.35"N, 73°57'12.48"W

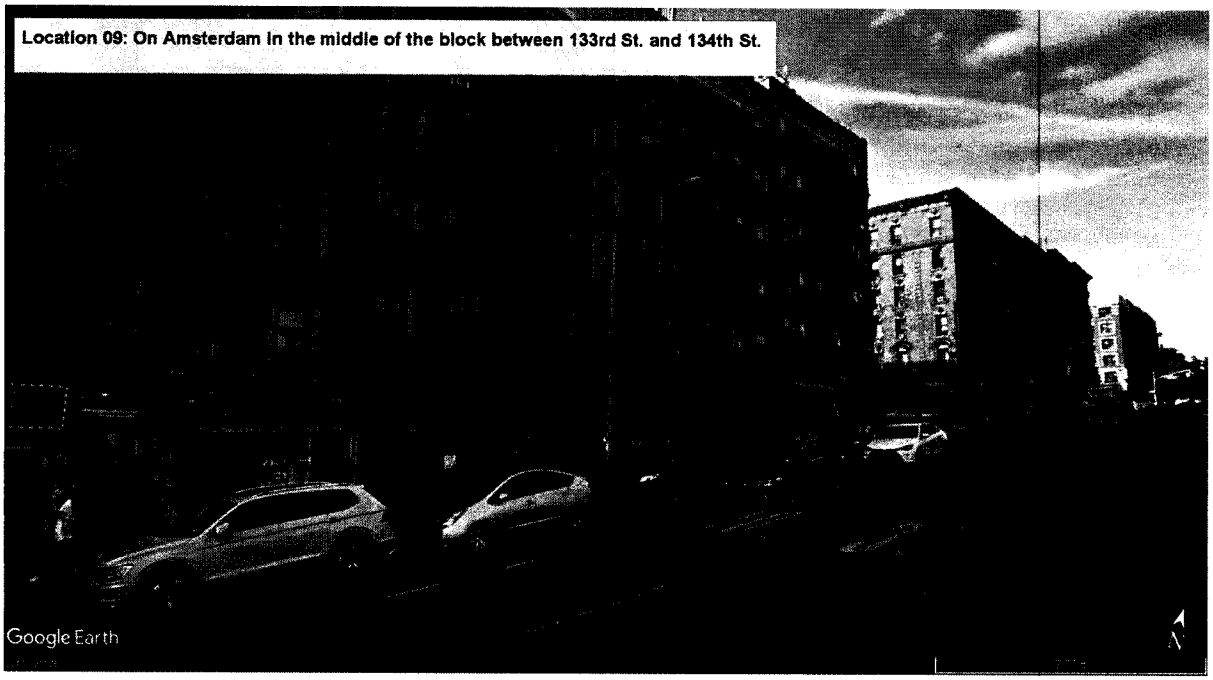
Map:



Notes:

Location 09: On Amsterdam in the middle of the block between 133rd St. and 134th St.
Coordinates: 40°49'4.57"N, 73°57'11.00"W

Map:

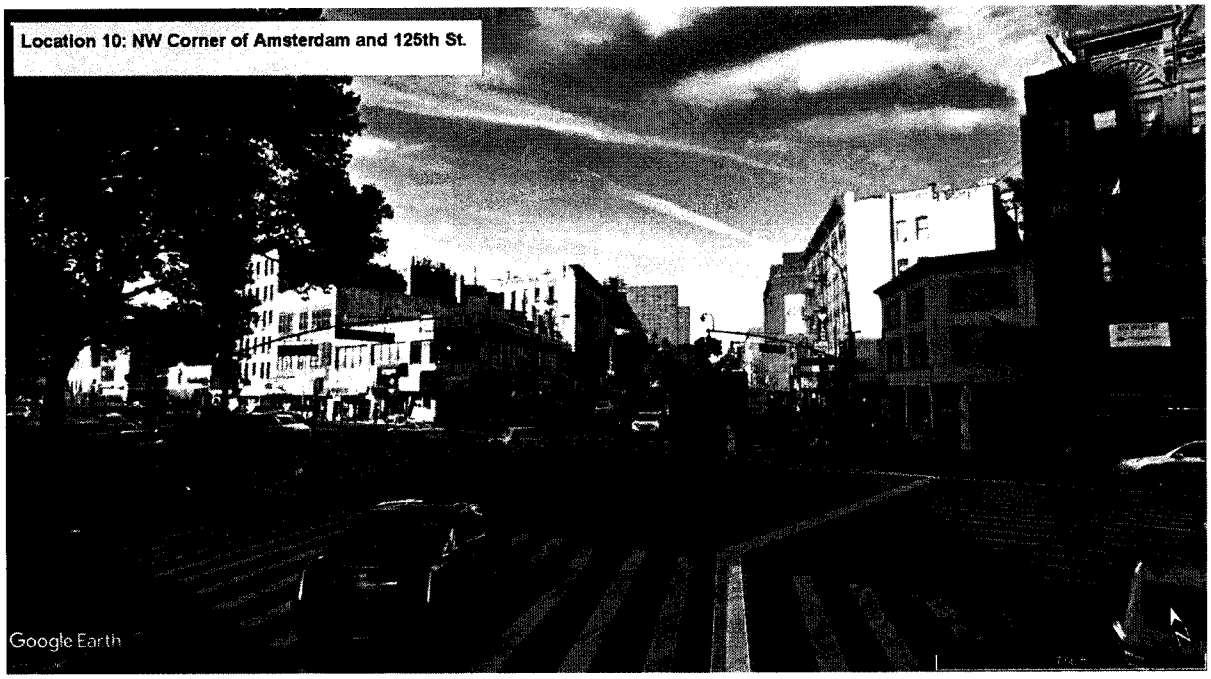


Notes:

Location 10: NW Corner of Amsterdam and 125th St.

Coordinates: 40°48'48.24"N, 73°57'21.95"W

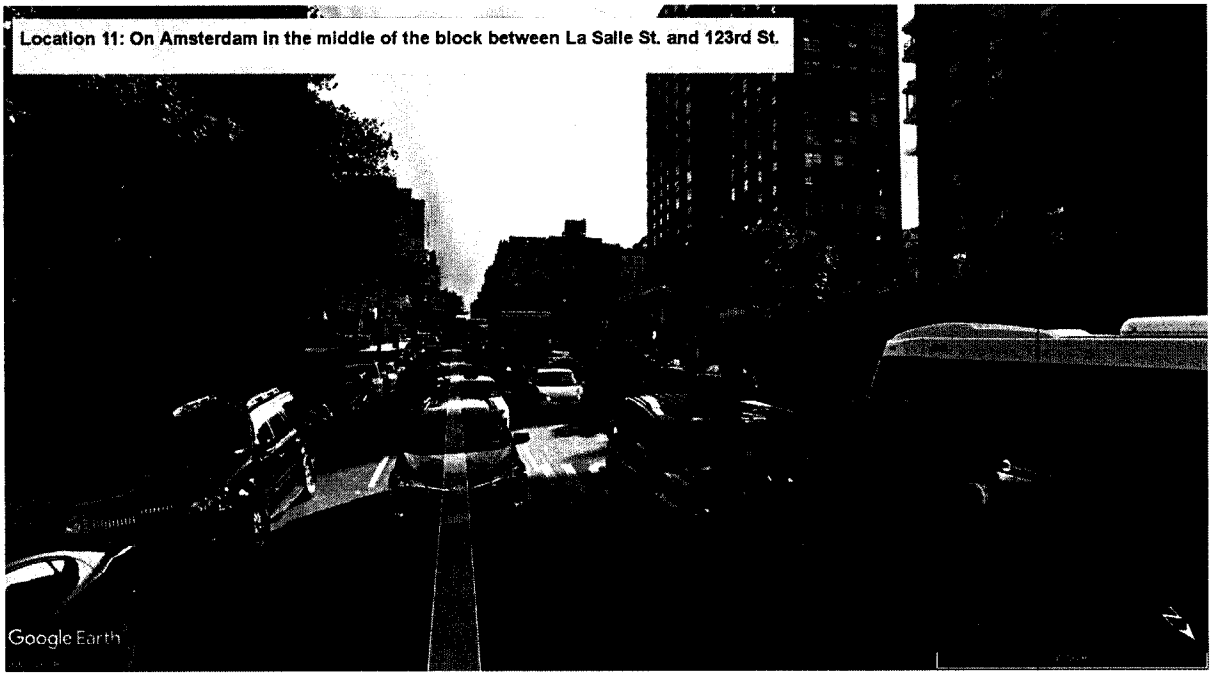
Map:



Notes:

Location 11: On Amsterdam in the middle of the block between La Salle St. and 123rd St.
Coordinates: 40°48'43.88"N, 73°57'26.06"W

Map:

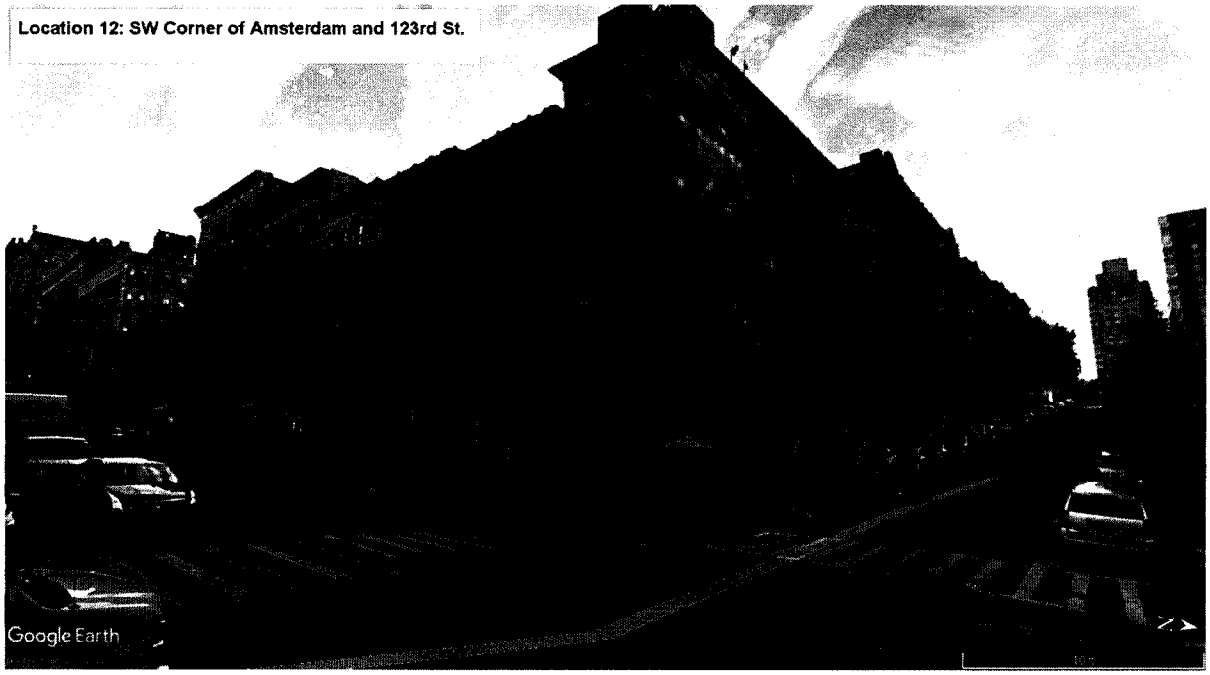


Notes:

Location 12: SW Corner of Amsterdam and 123rd St.

Coordinates: 40°48'40.74"N, 73°57'27.54"W

Map:



Notes:

TABLE for COSMOS Frequency of Operation

Spectrum Band	Center Freq	Tx Power (dBm)	Technology Enabled	Site location (If Known)	Geographic Region	Fixed or Mobile Transmitter	Radius of Operation	Incumbent Licensee
2.5-2.7 GHz	2590 MHz	+20	LTE, 5G	Loc01-10	NY, NY	Fixed	500 meters	Sprint
28GHz		+20	mmWave		NY, NY	Fixed		N/A
39GHz		+20	mmWave		NY, NY	Fixed		N/A
3.7-4.2 GHz		+20		Loc01-10		Mobile		N/A
5.9GHz		+20	DSRC	Loc03-12		Mobile		N/A